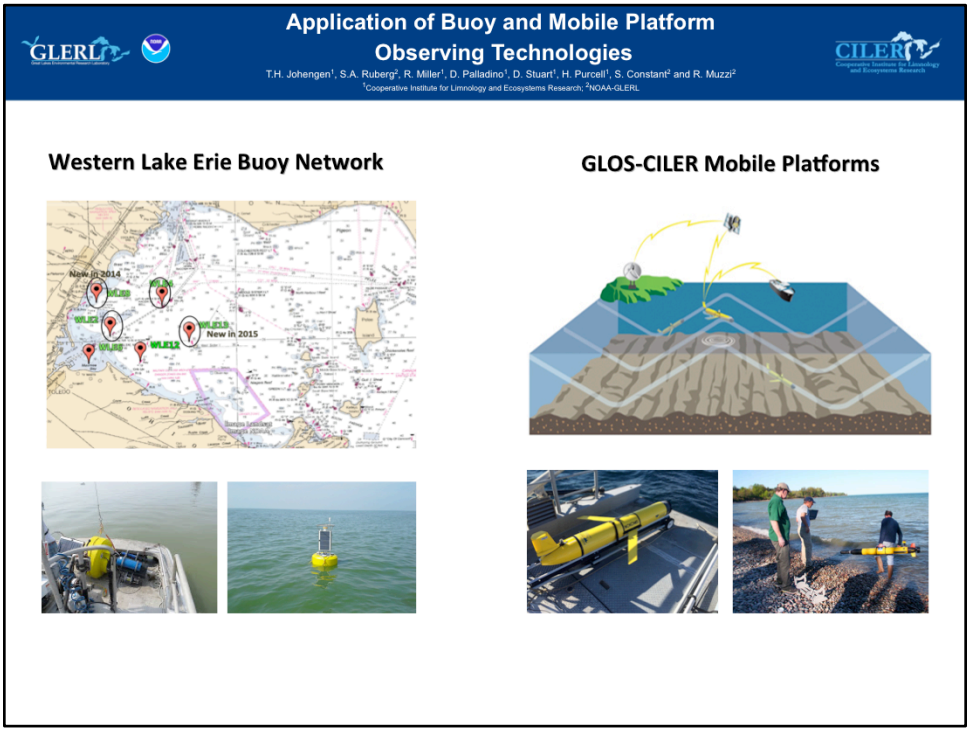

*CDOM isn't listed yet under monitoring

HAB: Harmful Algal Bloom
CTD: Conductivity, Temperature, Depth
DO: Dissolved Oxygen
TP & TDP: Total and Total Dissolved Phosphorus
SRP: Soluble Reactive Phosphorus
NO3: Nitrate
NH4: Ammonia
CHN: Carbon, Hydrogen and Nitrogen
DOC: Dissolved Organic Carbon
CDOM: Colored Dissolved Organic Material
CHL: Chlorophyll
TSS/VSS: Total Suspended Solids and Volatile Suspended Solids
PC: Phycocyanin
SpCond: Specific Conductivity
ESP: Environmental Sample Processor

Application of Buoy and Mobile Platform Observing Technologies

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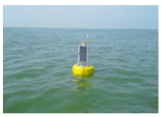
[1]Cooperative Institute for Limnology and Ecosystems Research; [2]NOAA-GLERL

Western Lake Erie Buoy Monitoring Network



Research Drivers

- Disseminate hourly summary of water quality conditions to better inform the public on the timing and distribution of HABs
- Inform the Great Lakes Water Quality Annex 4 adaptive management process to establish new target nutrient loads
- Evaluate the importance of resuspension versus riverine inputs for initiating, sustaining, and dispersing blooms (nutrients and seed-stocks)
- Support calibration and verification of remote sensed estimations produced for the operational HAB Bulletin and developmental HAB Tracker
- Support calibration and verification of N-P-Z based ecological forecasts

Research Approach

- Developed a network of 4 realtime continuous monitoring buoys to support HABs monitoring and forecasting.
- Data disseminated on GLERL HABs web site and GLOS.
- Buoys deployed from May – October and serviced approximately monthly.
- Nutrient concentrations determined hourly.
- CTD, fluorometry, pH, DO measured every 15 min
- Weekly discrete monitoring provides ground truth, direct measurement of particulate and dissolved toxicity levels, and samples for metagenomics

Monitoring
CTD profiles
TP
TDP
SRP
NO3
NH4
CHN
DOC
CHL
PC
Composition
Toxicity
Turbidity
TSS/VSS

Buoys
SRP
Temp
Cond
CHL
PC
Turbidity
CDOM,
pH,
DO

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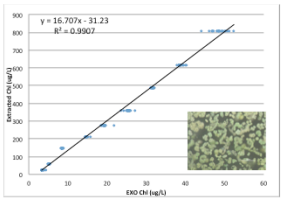
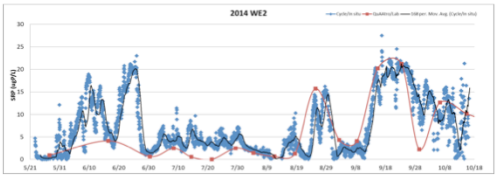
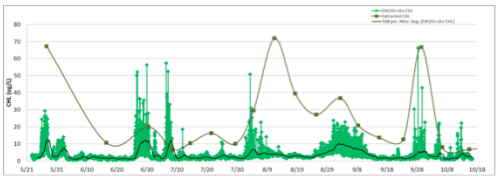
Western Lake Erie Buoy Monitoring Network

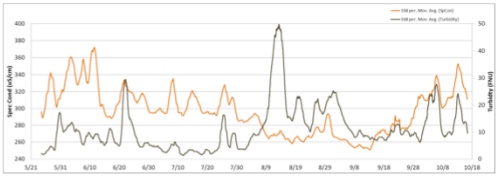
Project Results and Outcomes

- Buoys reveal dynamic water quality changes on hourly to daily time-scales
- Changes occur from both internal resuspension and advection of River plume
- Buoys can provide significant improvement in 'advanced warnings' of blooms
- Internal nutrient supplies may rival tributary loading at local scales and extend size and duration of blooms
- Non-quantitative relationship between in-situ fluorescence and HAB density









Application of Buoy and Mobile Platform Observing Technologies

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GLOS-CILER Mobile Platforms

Research Drivers

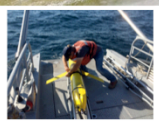
- Provide detailed spatial and temporal patterns of riverine inputs, thermal structure, and lower food web structure to support lake-scale ecological forecasting and GLERL's LTR programs
- Map distribution of invasive Quagga mussels and bottom habitat characteristics
- Map distributions of HABs as related to river plume and water quality characteristics
- Track vertical migration of HABs to support models and forecasts

Slocum G2 Glider

IVER-2 AUV

Research Approach

- Work with Federal (NOAA, EPA, USGS) and Academic Partners (UMD, MTU, UWM, SUNY-ESF) to operate the platforms regionally
- Support local and regional monitoring priorities



Joint mission with EPA and USGS in support of the 2015 Lake Michigan Coordinated Science Monitoring Initiative

Platform	Deployed / Retrieved	# days	# transects	# water column profiles	Linear Distance (km)
AUV	9-25-14	1	2		50 km
Glider	9-18-14 10-17-14	30	MILW boxes 2 lake crossings	3600	660 km
Glider	7-25-14 8-28-14	32	MUSK-MILW 6 lake crossings	2800	784 km
Glider	5-19-14 6-19-14	31	G.H. /MILW boxes 4 lake crossings	2950	679 km
Glider	9-27-13 10-28-13	31	MUSK-MILW 6 crossings	2375	726 km
Glider	6-26-13 7-11-13	16	MUSK/NDBC/MILW 2 crossings	780	266 km

Summary of mission days for GLIDER and AUV applications in 2014

Application of Buoy and Mobile Platform Observing Technologies

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GLOS-CILER Mobile Platforms

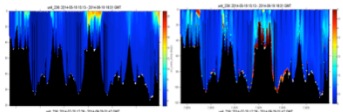
Project Results and Outcomes

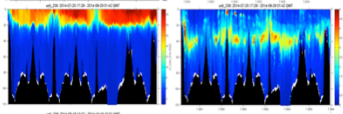
- Repeated cross-lake mapping of timing and spatial distribution of thermocline formation and development of deep chlorophyll layer.
- Detailed Nearshore mapping of river plume
- Data comparisons made with Ferry surface mapping, NDBC buoy, and GLERL LTR surveys.

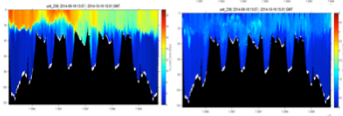
May – June

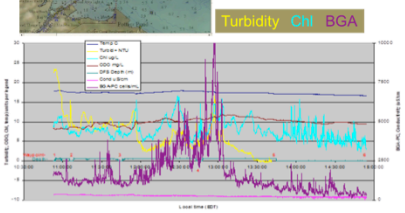
July – Aug

Sept - Oct

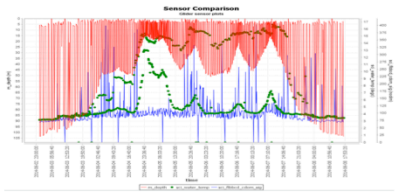








AUV tracking of river plume and boundaries of HABs in W. Lake Erie



GLIDER tracking river plume distribution in coastal L. Michigan. Can support FVCOM nearshore water quality forecasts (FIBs, spills, HABs)

Application of Buoy and Mobile Platform Observing Technologies

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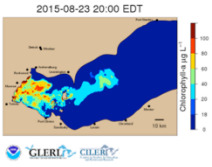
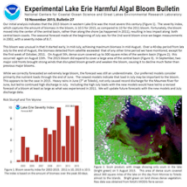
Future Directions

Buoy Network

- Provide continuous in-lake nutrient monitoring in support of GLWQA Annex 4
- Improve seasonal and weekly HAB forecasts through incorporation of continuous monitoring data
- Develop ESP technology to provide near realtime toxicity results (4 times per day)
- Complete NPZ mass-balance models to evaluate importance of various internal dynamics and support management scenarios
- Improve data product dissemination to stakeholder through ongoing engagement and outreach.





Mobile Platforms

- Climate and Heat Budgets – Evaporation, Lake Levels, Timing and Strength of Stratification, Species Distribution
- Vertical Distributions of HABS – AUV mapping and new moored Profiler
- Lake-scale Biophysical Models – parameterization and skill assessment
- Repeated time-series to fill in monthly spatial LTR surveys